

NASA TECH BRIEF

Goddard Space Flight Center



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Micrometeoroid Composition Analyzer

The problem:

The previous apparatus for determining the location and velocity of a particle moving relative to a detector assembly has frequently included a multitude of parallel metal-film strips. These strips are interconnected with an electrical network to determine the strip on which the particle impinges. Such devices have several disadvantages. The velocity of the particle impacting on the film is reduced, often to zero. The direction of motion of the particle is usually changed, and the mass of any particle penetrating the film tends to be reduced. In addition, the rotational or spinning frequency of an impacting particle tends to be decreased after the particle has penetrated the film, and any electrical charge on the particle is usually removed or altered by the interaction.

The solution:

A new technique has been developed to detect moving charged particles and to determine their positions and/or their velocity vectors, relative to three mutually orthogonal axes, without particle impact or any elements of a detector and without changing particle charge or motion.

How it's done:

Figure 1 is a side-sectional view of the electric charge detector. The detector incorporates three equally-spaced parallel metal grids through which a charged particle, such as a micrometeoroid, passes in a straight-line trajectory at constant velocity. The two outer grids are connected by a grounded lead, whereby the two define equipotential ground planes. The center grid is connected to a high input impedance, dc operational amplifier that has a reference terminal connected to ground.

The grids have a mesh structure and are supported by a single framework (not shown) such that the probability of a micrometeoroid impacting on any of them is substantially zero. The wires making up the grids, however, are sufficiently close to one another to enable a charge to be induced in the grids as a micrometeoroid passes through. There is no voltage from an external dc source connected to the grids so that passage of the particle through the detector has no substantial effect on the electrical, chemical, or dynamic properties of the particle.

As a positively charged micrometeoroid passes through the detector, the output voltage of the amplifier (Figure 1) increases from zero to a maximum, V_{MAX} , when the micrometeoroid passes through the plane of the center grid. V_{MAX} is proportional to the charge on the particle. The output voltage of the amplifier returns to zero potential when the micrometeoroid passes through the plane of the second outer grid.

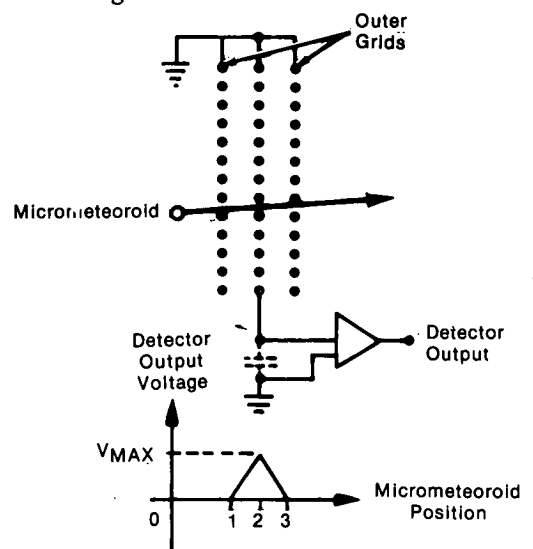


Figure 1. Moving Charged-Particle Detector

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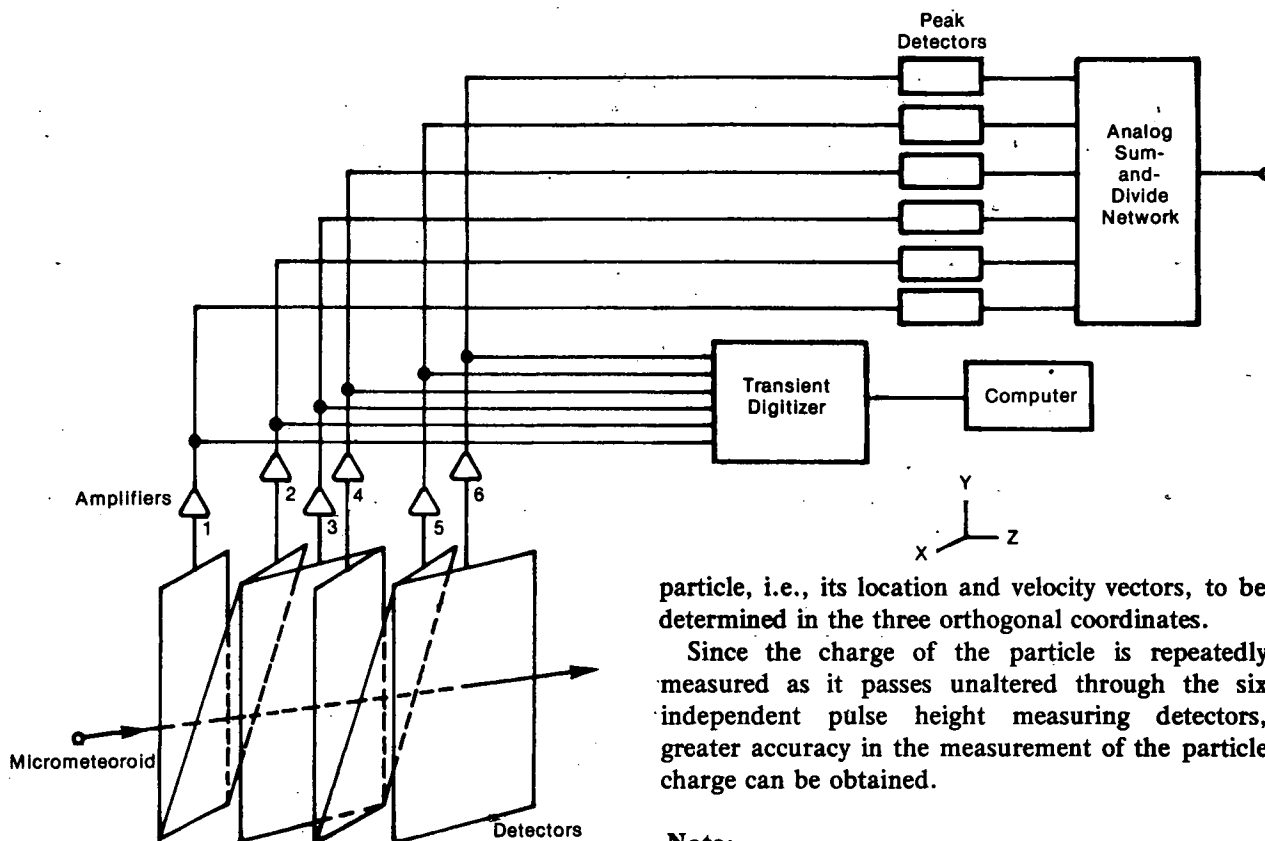


Figure 2. Micrometeoroid Velocity-and-Trajectory Analyzer

The three grids of Figure 1, taken as shown, form a single planar detector. Six of these detectors arranged in three pairs, as shown in Figure 2, enable the position and/or velocity vectors of the particle to be determined relative to three mutually orthogonal axes, X, Y, and Z.

Each of these detectors produces a separate output pulse as a moving charged particle passes through the array. These pulses are amplified, and each is applied to a separate peak detector. The outputs of each of these are then applied to an analog network which, after the passage of the particles, sums them and divides the sum by the number of detectors, thereby giving an indication of the charge of the particle. After the particle passes through the detector, it may be subject to further analysis.

The amplified pulses are also applied to a transient digitizer. It produces a digital output signal indicating the times at which the particle passes through the subsequent planes defined by the detectors relative to the time at which it passes through the first such plane (detector 1). This output signal is then processed by a computer which solves the appropriate sets of equations, based on the geometry and the dimensions of the detector array, enabling the trajectory of the

particle, i.e., its location and velocity vectors, to be determined in the three orthogonal coordinates.

Since the charge of the particle is repeatedly measured as it passes unaltered through the six independent pulse height measuring detectors, greater accuracy in the measurement of the particle charge can be obtained.

Note:

Requests for further information may be directed to:

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Reference: TSP74-10287

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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